Space Weather Technical Forecast

Issued on Thursday, 06 July 2023 at 01:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Active fluence declining. Chance of R1/R2 radio blackouts. G1/Minor Storm to G2/Moderate Storm possible late 06 July or early 07 July with CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with one M flare originating from AR3354 on the northwest limb, peaking at M1.0 at 05/1858 UTC. AR3354 has rotated round the northwest limb to the far side through this period but is presumed to still be very large and complex. This leaves 6 numbered sunspots on the visible disc. Both AR3359 in the southern central disc and AR3361 in the northeast have shown signs of development during the period and are in a moderately complex beta-gamma formation. AR3357 and AR3358 in the southern central disc have decayed during the period and their spots are becoming increasingly difficult to discern. The other two regions on the disc are relatively small and simple with little change observed.
No Earth directed CMEs have been observed on available imagery in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1, perhaps indicates the arrival of a weak, transient CME. Solar winds were at ambient levels around 350 km/s but rose from 05/1500 UTC to around 420 km/s. The density was average, but has increased to slightly above average at times from 05/1115 UTC, with a peak of 25 ppcc at 05/2130 UTC. IMF was weak (<8 nT), but increased from 05/1315 UTC, with moderate levels (8-12 nT) observed from 05/1843 UTC. However, the north-south component has continued to vary weakly between -5 and +4 nT. The phi angle has oscillated but has been predominantly positive (away from the Sun) since 05/1710 UTC. Geomagnetic activity has been mostly Quiet (Kp 0-2), but an Unsettled (Kp 3) period was observed 05/2100-2400 UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at background levels. High energy electron flux (greater than 2MeV), as observed by GOES16, was at Moderate to High levels, peaking at 3580pfu at 05/1650 UTC. The 24-hour integrated fluence has been on a flat trend just above the Active (>1e8 integrated pfu) threshold throughout. A fluence of 1.4e8 pfu was recorded at 06/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low activity is likely during the forecast period, with a chance of further M-class flares, and a slight chance of an isolated X-class flare early in the period. The risk is mostly coming from AR3354 which is just round the northwest limb. As this region rotates further round the far side the flare risk reduces.

Solar Wind / Geomagnetic Activity: A partial halo CME from a filament eruption near AR3359 on 04 July has been analysed and appears to be Earth-directed, with a likely arrival at Earth either late on the 06 or early on 07 July. Otherwise, solar winds are forecast to become elevated to around 500-600 km/s on day 2 (07 July) due to the arrival of the high speed stream from

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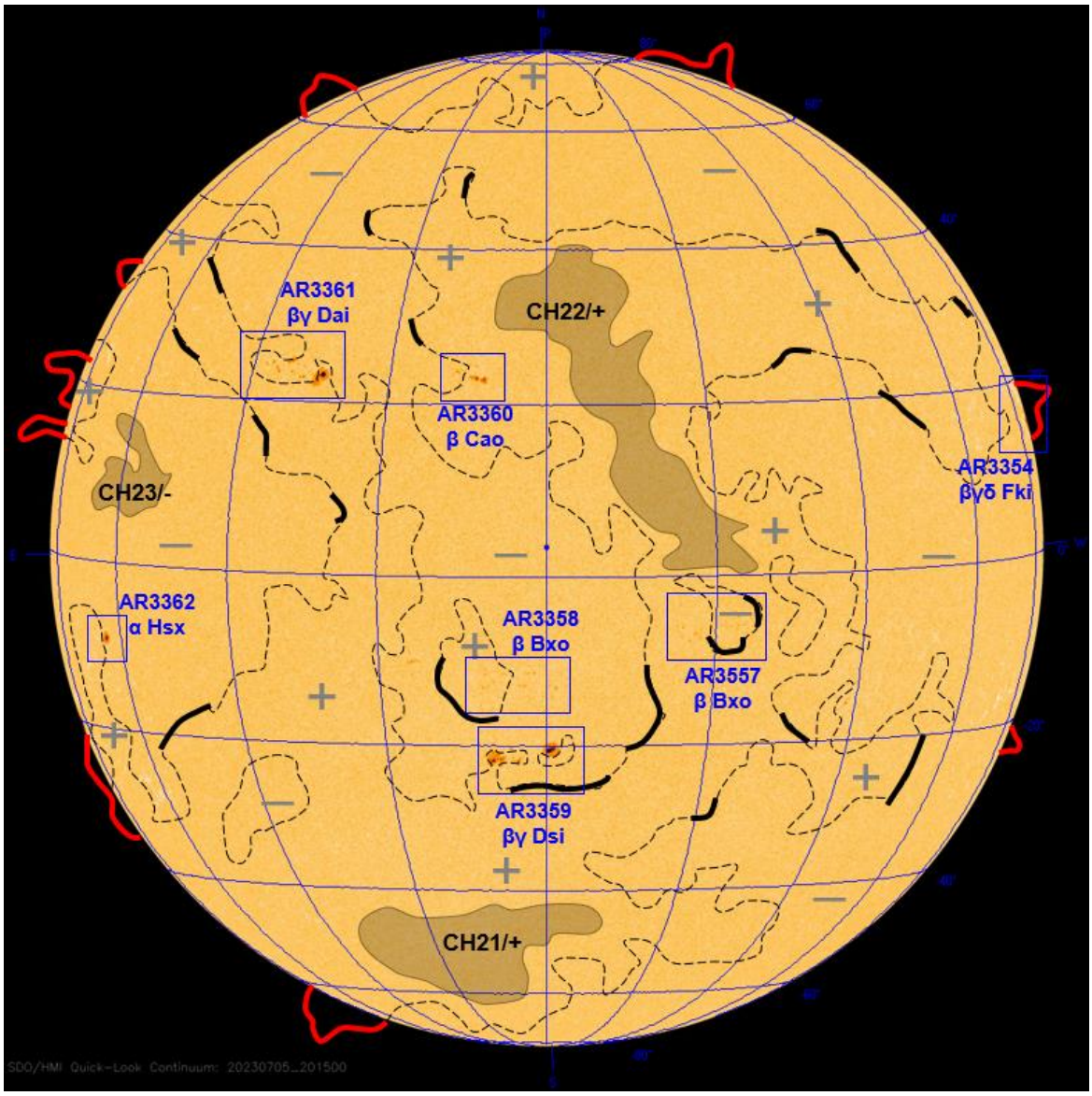
coronal hole 22. Geomagnetic activity is forecast to be mainly Quiet to Unsettled at first, but increasing to Unsettled to Active with a risk of G1 or G2 (Minor or Moderate) storms due to the effects of the CME arrival either late on 06 July or during 07 July. There is also a very slight chance of G3 Strong storms, but with low confidence. Heightened geomagnetic activity is then possible through into 08 July, before waning during day 4 (09 July).

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight but declining chance of reaching the S1/Minor Storm threshold through the period. The risk reduces as AR3354 continues to rotate away from the northwest limb on the far side. High energy electron flux (greater than 2MeV) is expected to decline, with a sharper drop likely as the CME arrives later on 06 or 07 July. The corresponding fluence is above the Active (1e8 integrated flux) threshold and is also expected to drop rapidly with the CME arrival.

Figure 1. Solar Analysis Valid 05/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A partial halo CME with a forecast speed of 700km/s left the Sun on 04 July and is forecast to arrive at Earth either late on 06 or early 07 July, with a slight bias towards later in that range.
Solar wind speeds are currently at ambient to slightly elevated levels, but are forecast to increase due to a connection to coronal hole 22. This is a persistent feature which produced speeds of 500km/s on the last rotation with a comparable appearance on this rotation. Based on this speed, a connection on 07 July is forecast with speeds in the range 500-600km/s.
Geomagnetic activity is expected to be mainly Quiet to Unsettled initially, increasing to Unsettled to Active, due to the arrival of the forecast CME. There is a likelihood of G1 or G2 (Minor or Moderate) storms, with a slight chance of G3 Strong storms, with the risk higher for the most likely arrival time early on day 2 (07 July). The connection of the coronal hole may be masked by the CME arrival, although this connection could produce Active intervals should this occur before the CME arrival. Residual effects are then possible through into 08 July, before waning during day 4 (09 July).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	60	30	5
Strong	G3	No	5	10	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1000	Partial	Filament	SE Quadrant	700 km/s	07/0000 UTC +/- 12 hours	G1/G2 shock likely.

Figure 2: Enlil forecast and ensemble showing CME arrival.

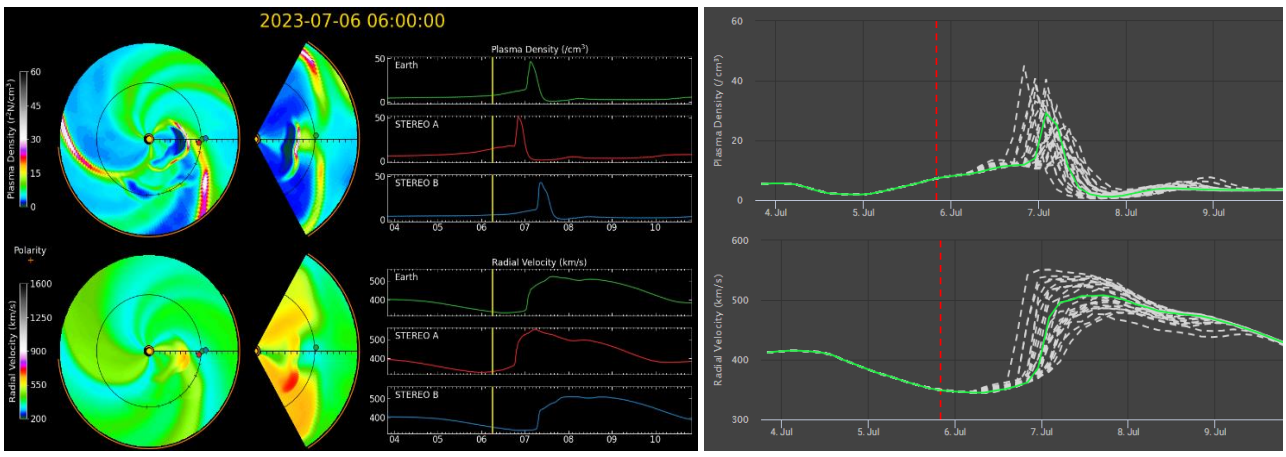

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Figure 3: SDO/AIA 211 coronal hole comparison previous rotation (left) this rotation (right)

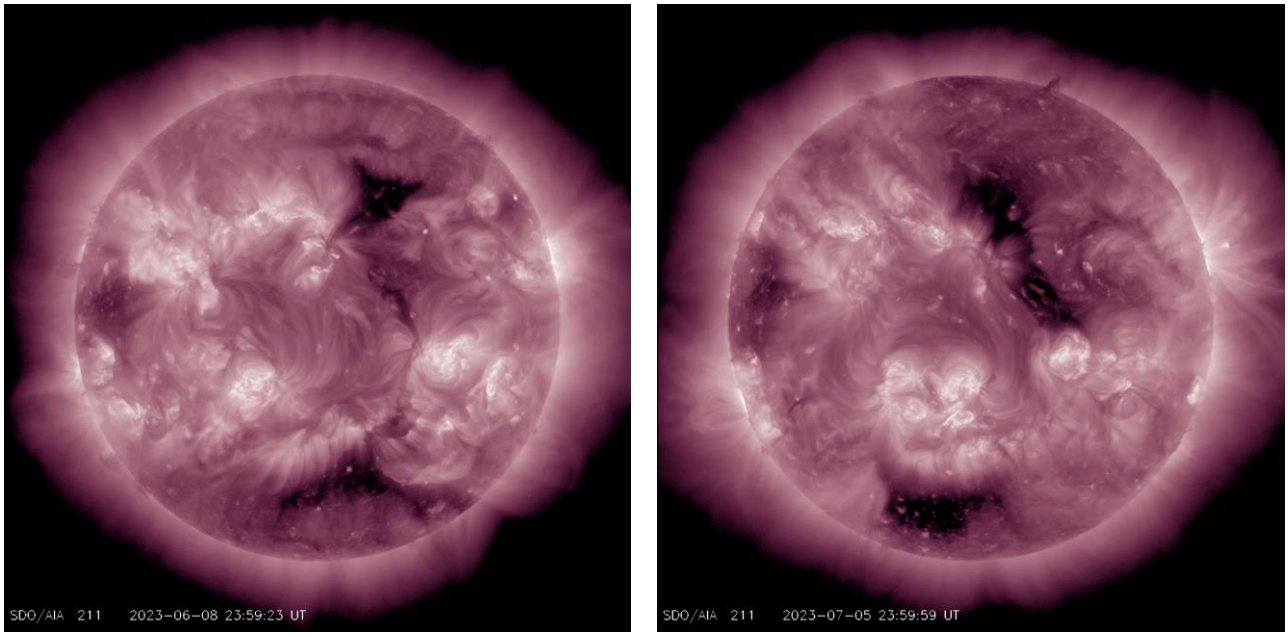
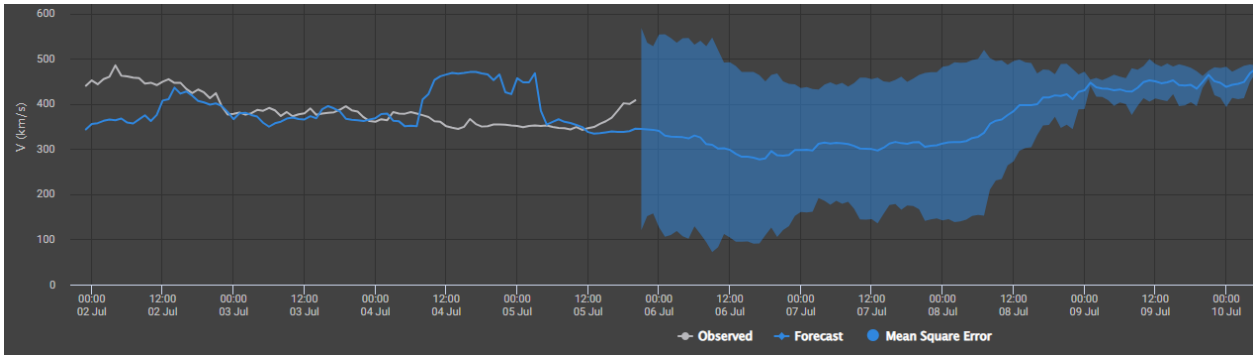


Figure 4: MOSWOC Solar Wind Persistence Model



Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate, with only one M-class flare recently observed from AR3354. This region has now transited round the northwest limb to the far side but is assumed to still be very large and magnetically complex. This leaves AR3359 (Dsi/Beta-Gamma) in the southern central disc as the largest and most complex region. Another region of note is AR3361, which continues to develop in the northeast quadrant. It is now classified Dai/Beta-Gamma. There are presently up to five other regions on the disc but these are relatively small and simple, with no significant flare activity.
Solar activity is forecast to be mainly Low, with a chance of Moderate flares, and a slight chance of an isolated Strong flare early in the period, whilst AR3354 remains close to the western limb on the far side.

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X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	30	25	25
Very Active	R3 to R5 X Class	No	10	5	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. There is a slight but declining chance of S1/Minor storm levels being reached through this period. This is mainly due to AR3354, given its favourable location near the western limb and although it has now transited to the far side the risk of radiation storms remains until it has rotated further round. The remaining regions on the disk currently only pose a very slight chance of a radiation storm.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	5	5	2
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) will start at mainly high levels, but with a declining peak due to the muted solar wind speeds. The reaction of electron flux to the forecast CME and high speed stream is uncertain, but a geomagnetic storm is likely to result in a redistribution of electrons and a possible distortion of the radiation belts away from GEO orbit.
Based on this there is likely to be a sharp decline in electron counts due to the initial impacts of the CME and high speed stream onset with a steady recovery thereafter. Electron fluence is therefore likely to experience a notable fall through 07 July, with a slow trend towards the Active threshold later in the period.

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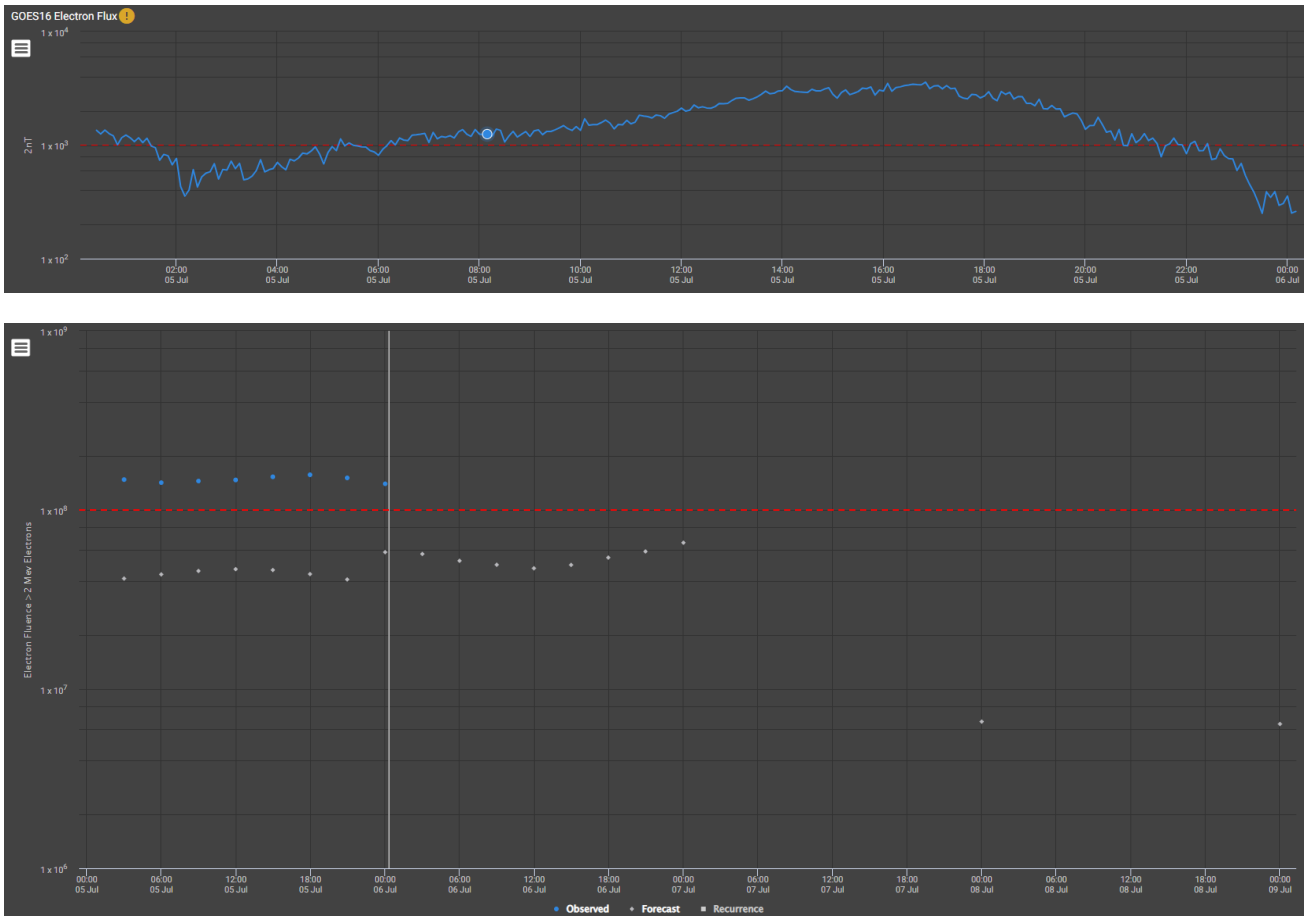
GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	70	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES16 electron flux and fluence plus REFM.



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